Evaluation of Pollution Sources to Lake Glenville
Quarterly Report – February 2018

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Summary

Chemical and microbial analysis of water samples collected at Lake Glenville area sites help to characterize water quality in relation to potential sources of water pollution. Overall water quality, as evidenced by data collected on February 27, 2018, is acceptable but there is evidence to suggest the influence of nutrient cycling on water quality. The observed nitrate and phosphate concentrations are lower compared to those observed in November 2017, which is likely due to the ecological processing of leaf litter and detritus combined with reduced inputs of these organic materials during the winter months. The next quarterly monitoring event will take place in May 2018. Results from that monitoring event will be evaluated individually and in relation to the results presented in this report to evaluate temporal changes in water quality and evaluate sources of pollution.

Methodology

Lake Glenville area samples were collected on Tuesday, February 27, 2018. At each sampling location, the following data were collected: creek name, time of sample collection, pH, dissolved oxygen, conductivity, air temperature, and water temperature. Weather conditions during the time of sample collection were also recorded. Samples were collected in triplicate at each site in labeled 2L Nalgene™ bottles and transported to Western Carolina University's Environmental Health lab on ice. Upon arrival to the Environmental Health lab, samples were analyzed for the following parameters within 6 hours: alkalinity, ammonia (NH_3), nitrates (NO_3), orthophosphates (as PO_4), total suspended solids (TSS), turbidity, and *E. coli*. Detailed explanations of laboratory analyses are available upon request.

Results

Acidity and Alkalinity: pH is used to measure acidity. The ambient water quality standard for pH is between 6.0 and 9.0, although natural pH in area streams generally ranges from 6.5-7.2. Values below 6.5 may indicate the effects of acid precipitation or other acidic inputs, and values above 7.5 may indicate industrial discharge. Glenville and Pine Creeks exhibited pH readings below 6.5 (Figure 1). All February 2018 pH measurements were lower compared to previous months and with the exception of Glenville and Pine Creeks, these pH observations are still within the North Carolina water quality standard for freshwater aquatic life.

Alkalinity is the measure of the pH buffering capacity of a water or soil. High alkalinity waters are generally better protected against acid inputs from sources such as acid rain, organic matter, and industrial effluent. Waters with an alkalinity below 30mg/L are considered to have low alkalinity. The observed mean alkalinity concentrations demonstrate low alkalinity in all monitored creeks (Figure 2). The lower alkalinity concentrations in February 2018 compared to November 2017 may account for the observed lower pH measurements as the waters have little buffering capacity and are more susceptible to changes in pH.

Figure 1. pH levels at each monitoring site, February 2018

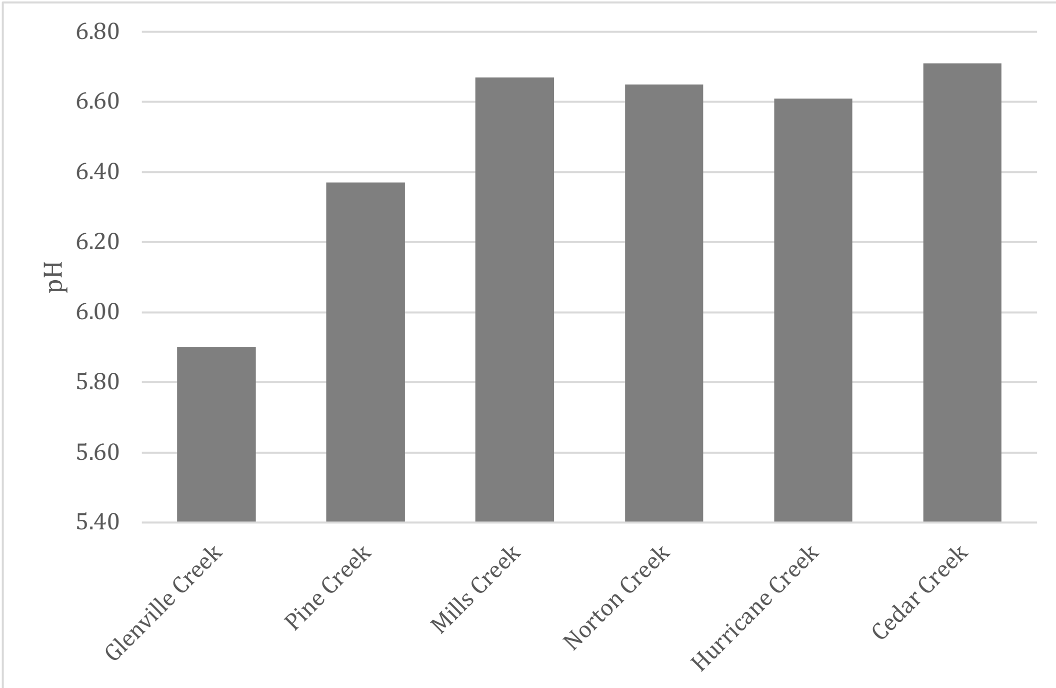
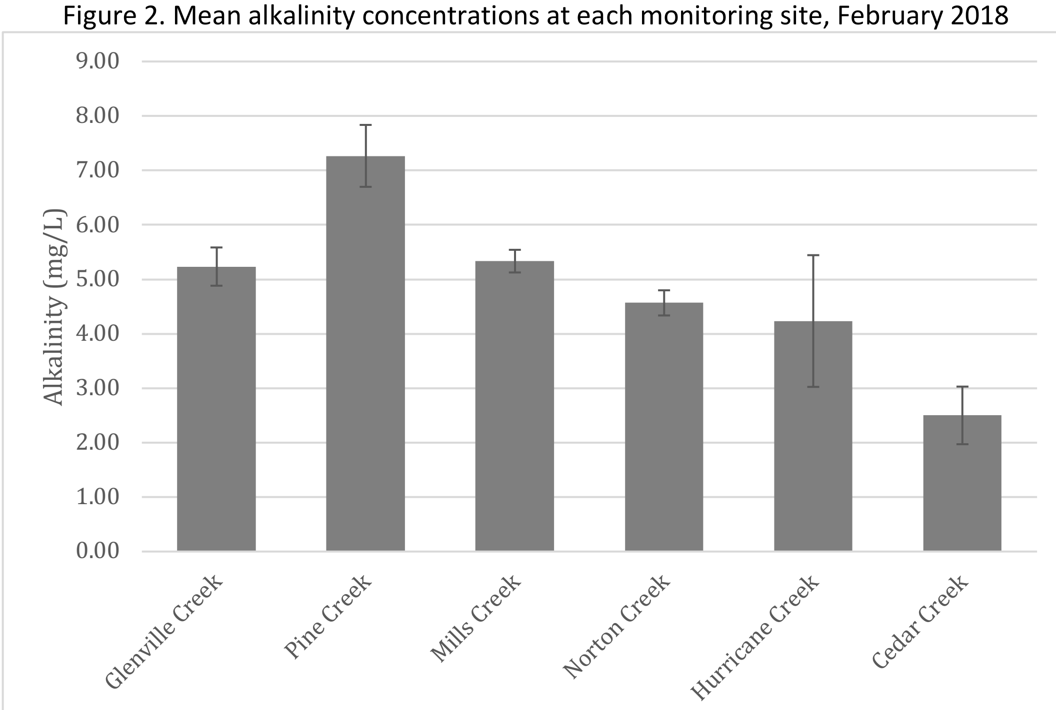


Figure 2. Mean alkalinity concentrations at each monitoring site, February 2018



Turbidity and Total Suspended Solids (TSS): Turbidity is a measure of visual water clarity and is a measure of the presence of suspended particulate matter. The standard for trout-designated waters is 10 NTU and the standard to protect other aquatic life is 50 NTU. Turbidity measurements in all creeks are below the 10 NTU trout-designated water standard (Figure 3). TSS quantifies solids by weight and is heavily influenced by a combination of stream flow and land disturbances. Although there is no legal standard for TSS, concentrations below 30mg/L are generally considered low. All monitoring sites exhibited low TSS concentrations (Figure 4). While moderately heavy precipitation events and land disturbance can increase turbidity and TSS concentrations, the undisturbed forested areas and presence of riparian zones in the Lake Glenville area likely influenced the low turbidity and TSS concentrations. Approximately 0.5 inches of precipitation fell in the 7 days preceding sample collection which was not expected to significantly influence turbidity and TSS concentrations. Turbidity and TSS concentrations in February 2018 were comparable to those observed in November 2107.

Figure 3. Mean turbidity levels at each monitoring site, February 2018

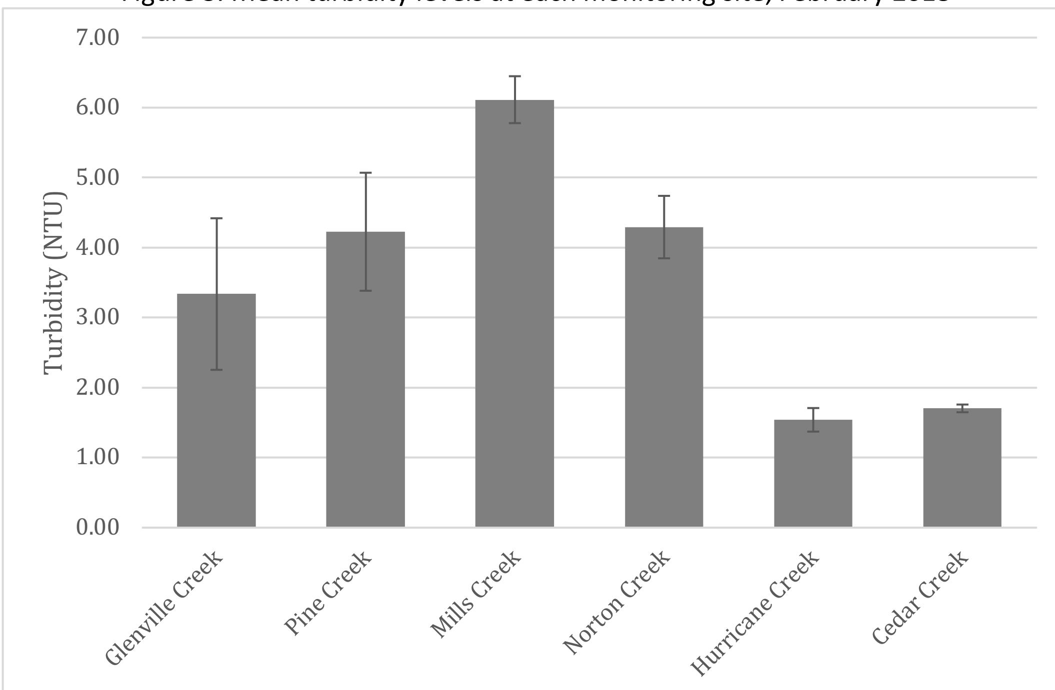
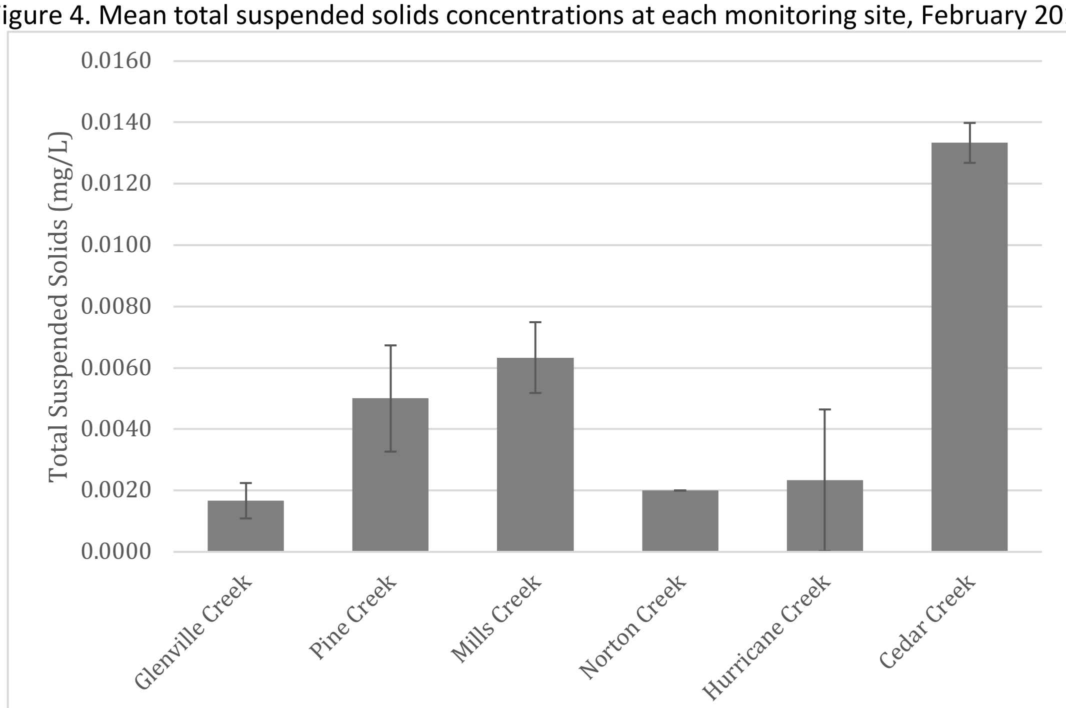
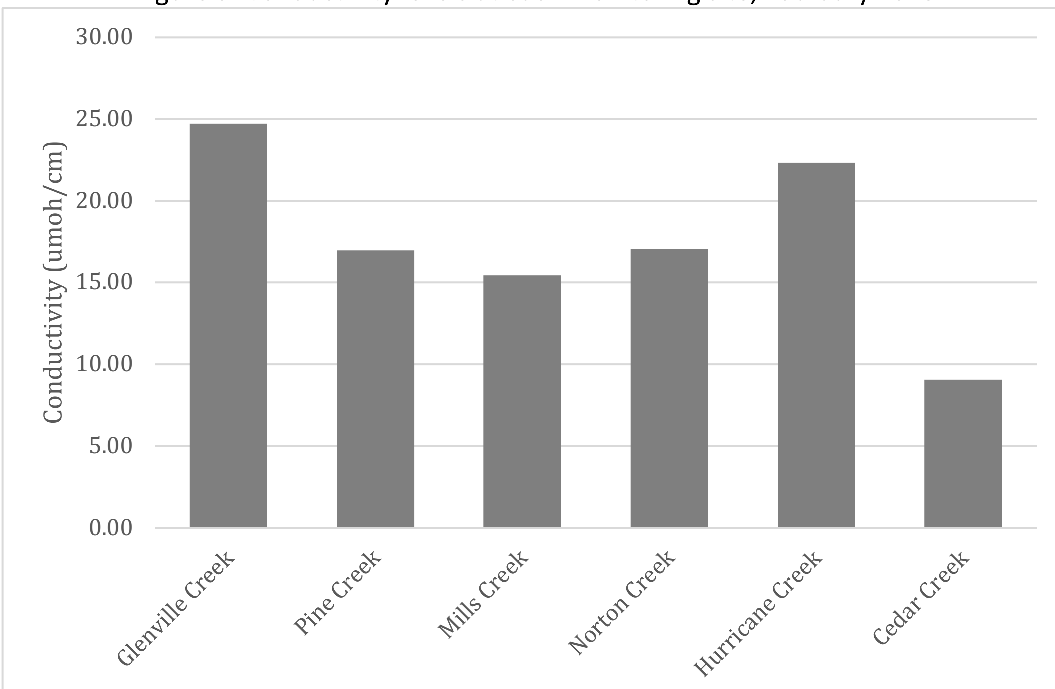


Figure 4. Mean total suspended solids concentrations at each monitoring site, February 2018



Conductivity: Conductivity is used to measure the ability of water to conduct an electrical current. Samples containing dissolved solids and salts will form ions that will conduct an electrical current and the concentration of dissolved ions in a sample determines conductivity. Inorganic dissolved solids such as chloride, nitrate, phosphate, calcium, sulfate, iron, sodium, and aluminum will affect conductivity levels and local geologic conditions will influence the types and extent of dissolved ions. Elevated levels of conductivity are most often seen in streams receiving wastewater discharge, urban runoff, or eroded soils. The observed conductivity levels at each monitoring site are relatively high considering the undisturbed forested landscape (Figure 5) but are lower compared to the conductivity measurements observed in November 2017. The observed conductivity levels do not correlate with TSS or turbidity, suggesting that the source of dissolved ions is not wastewater or soil runoff. The decreased February 2018 conductivity measurements as compared to those observed in November 2017 may reflect a decreased concentration of ions as a result of observed elevated water volume.

Figure 5. Conductivity levels at each monitoring site, February 2018



Nutrients (Orthophosphate [PO_4^{3-}], Ammonia [NH_3], and Nitrate [NO_3^-]): Phosphorus is an essential nutrient for aquatic plants and algae, and is typically the limiting nutrient in most aquatic systems thereby restricting plant growth in an ecosystem. Phosphorus is introduced into water systems from soil, wastewater treatment systems, failing septic systems, and runoff from fertilized land. Excessive phosphorus stimulates excessive plant growth and results in eutrophication, a condition that can result in dissolved oxygen depletion in an aquatic ecosystem. Orthophosphate is the amount of phosphorus that is immediately available to plants or algae for biological assimilation. Generally, orthophosphate levels below 0.05 mg/L are sufficient to prevent eutrophication.

There is no legal water quality standard for orthophosphate, but the Environmental Protection Agency (EPA) nutrient criteria for total phosphorus in rivers and streams in this ecoregion is 0.01 mg/L. Although orthophosphate is only one component of total phosphorous, observed concentrations at all monitored sites exceed the EPA nutrient criteria for total phosphorous (Figure 6). All sites exhibited a decrease in orthophosphate concentrations compared to those observed in November 2017 which is most likely explained by the effective processing and cycling of organic matter input from leaf litter and detritus deposited during the fall months.

Ammonia is contained in decaying plant and animal remains and microbial decomposition of these organic wastes can release ammonia. The most likely sources of ammonia are agricultural runoff, livestock farming, septic drainage, and sewage treatment plants. The ambient concentration of ammonia in water is approximately 0.10 mg/L but concentrations are heavily influenced by water temperature and pH., Mills, Norton, and Cedar Creeks exceeded this "norm," most likely as a result of the accumulation of leaf litter and detritus. No creek exceeds the ambient total ammonia toxicity standard of 1.9 mg/L (Figure 7).

Like phosphorus, nitrate serves as an algal nutrient and can contribute to excessive plant growth and eutrophication. Common sources of nitrate include septic drainage and fertilizer runoff from agricultural land and domestic lawns. The ability of nitrate to more readily dissolve in water contributes to its increased likelihood of traveling in surface waters. As a result, nitrate is a good indicator of sewage or animal waste input. There is no legal water quality standard for nitrate, but the EPA nutrient criteria for total nitrogen in rivers and streams in this ecoregion is 0.31 mg/L. Although nitrate is only one component of total nitrogen, observed concentrations at all monitored sites exceed the EPA nutrient criteria for total nitrogen (Figure 8). The lack of correlation between nitrate concentrations and TSS or turbidity suggesting that agricultural runoff of livestock wastes may continue to be a source of nitrate. The observed nitrate concentrations are lower in all creeks compared to those observed in November 2017, which may also be the result of leaf litter and detritus processing, as well as reduced agricultural activities.

Figure 6. Mean orthophosphate concentrations at each monitored site, February 2018

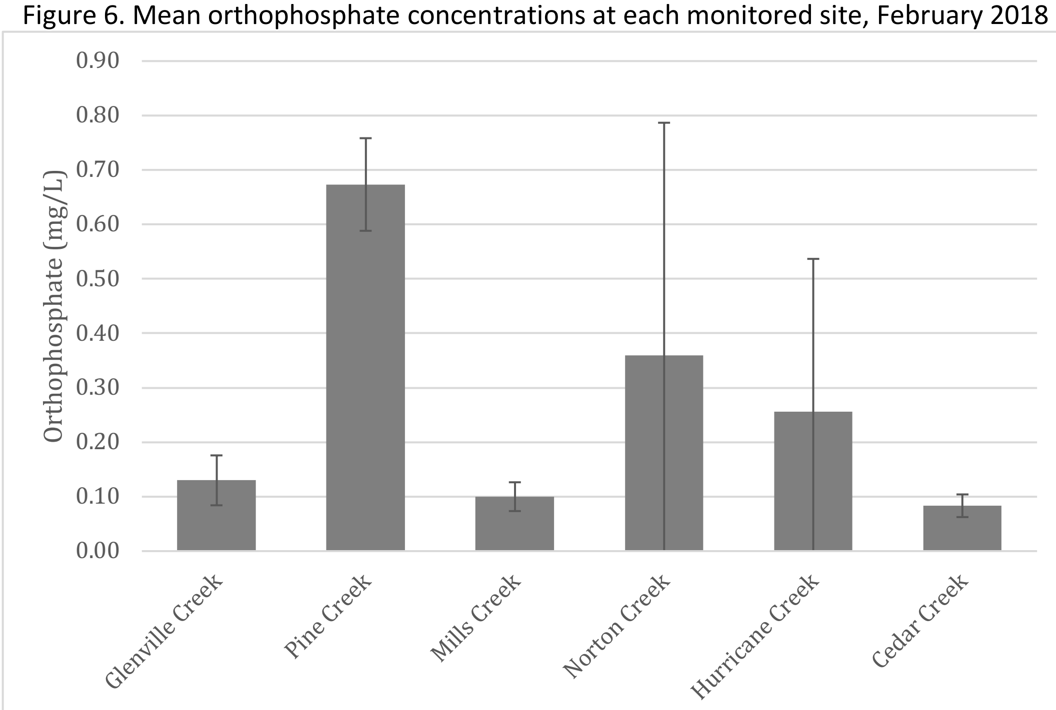


Figure 7. Mean ammonia concentrations at each monitored site, February 2018

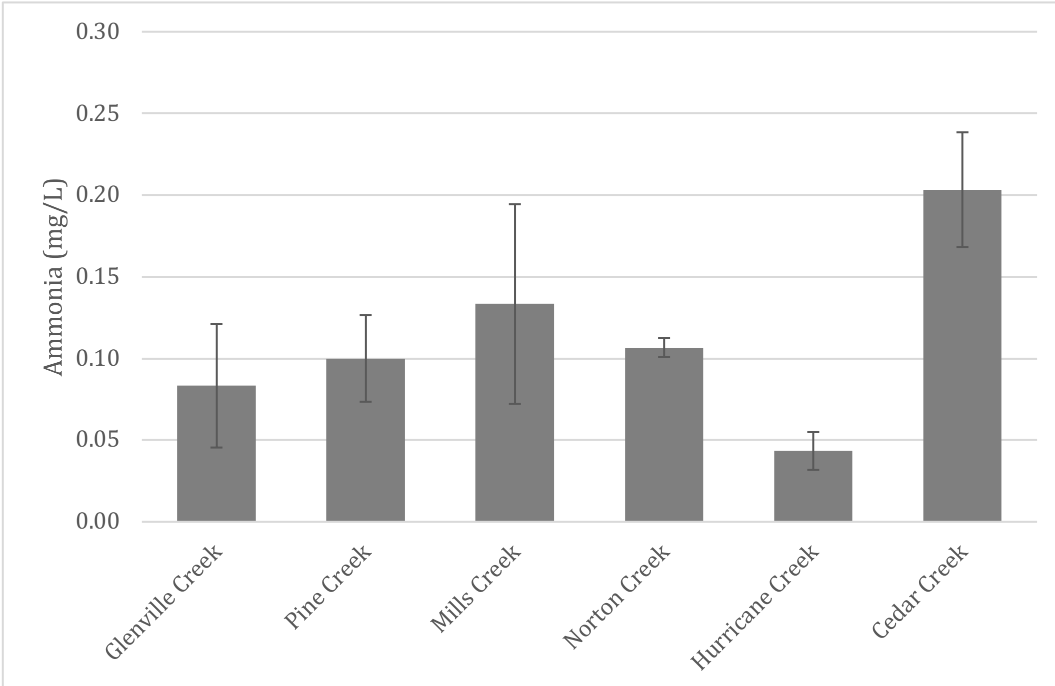
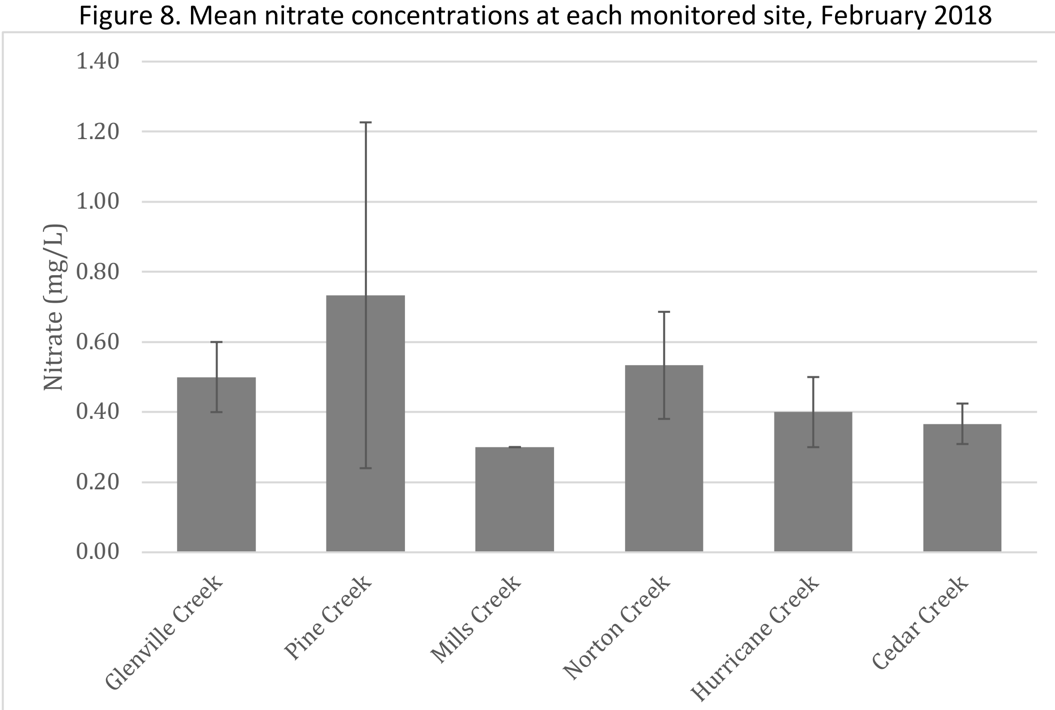


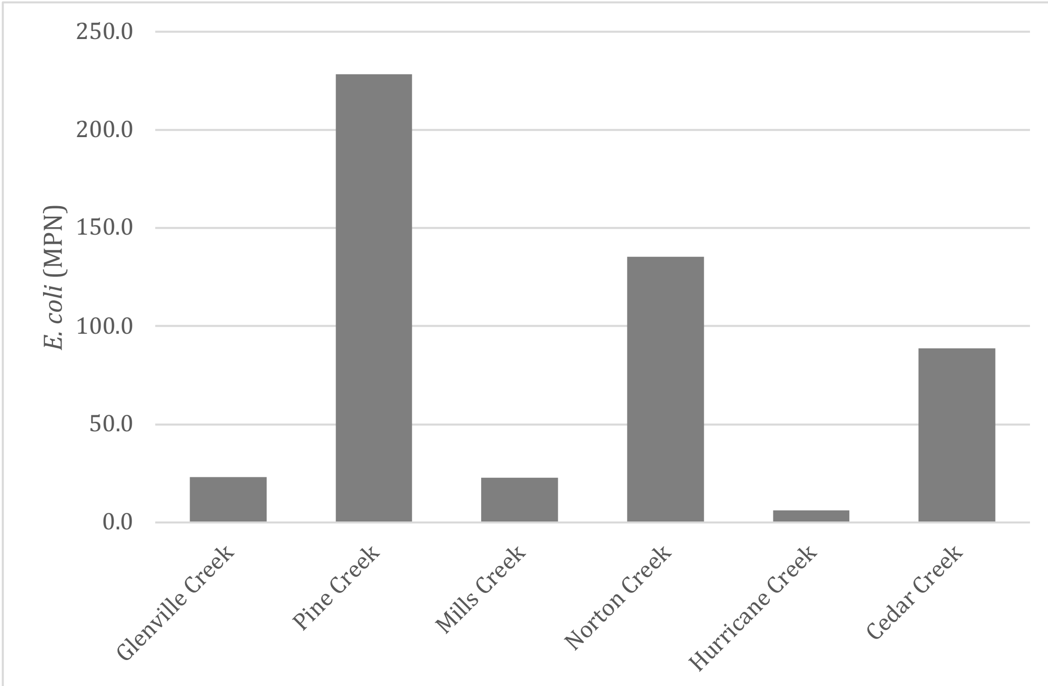
Figure 8. Mean nitrate concentrations at each monitored site, February 2018



***E. coli*:**

The potential presence of fecal pathogens in surface water is determined based on a surrogate measurement if fecal indicator organisms, including *E. coli*. The recreational standard for *E. coli* in the State of North Carolina is 200 CFU/100ml. All monitored sites except Pine Creek exhibit *E. coli* concentrations below this standard (Figure 9). The presence of livestock on surrounding land may be a contributing factor to the observed *E. coli* concentrations in Pine Creek at this time. *E. coli* concentrations in surface waters have been shown to be influenced in part by seasonality, and future sampling events will continue to monitor *E. coli* to identify possible influences of seasonality on fecal pollution in the creeks discharging into Lake Glenville.

Figure 9. *E. coli* concentrations at each monitored site, February 2018



Conclusions

Chemical and microbial analysis of water samples collected at Lake Glenville area sites help to characterize water quality in relation to potential sources of water pollution. Overall water quality, as evidenced by data collected on February 27, 2018, is acceptable but there is evidence to suggest the influence of nutrient cycling on water quality. The observed nitrate and orthophosphate concentrations are lower compared to those observed in November 2017, which is likely the result of leaf litter and detritus processing and nutrient cycling combined with reduced inputs of these organic materials during the winter months. Lower pH measurements may be influenced by a combination of discharges and low alkalinity. Relatively low turbidity and TSS concentrations are likely the result of undisturbed forested land use patterns and riparian buffers long the creeks. The lack of correlation between turbidity or TSS with ammonia, orthophosphate, or nitrate concentrations suggest that the introduction and processing of organic matter, not soil erosion or surface runoff, is contributing to elevated nutrient concentrations. The next quarterly monitoring event will take place in May 2018. Results from that monitoring event will be evaluated individually and in relation to the results presented in this report to evaluate temporal changes in water quality and evaluate sources of pollution.